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KOMMISSIONEN FOR DANMARKS FISKERI- OG HAVUNDERSØGELSER

SERIE: FISKERI · BIND XI

NR. 5. FREDE HERMANN: A RECORDING DEPTH GAUGE FOR USE IN HORIZONTAL HAULS WITH STRAMINE NETS AND OTHER PELAGIC FISHING IMPLEMENTS

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI
1949

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A RECORDING DEPTH GAUGE FOR USE IN HORIZONTAL HAULS WITH STRAMINE NETS AND OTHER PELAGIC FISHING IMPLEMENTS

BY

FREDE HERMANN

WITH 6 TEXT-FIGURES

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Introduction.

In pelagic hauls with stramine nets and other fishing gears moving through free masses of water it is important in biological research work to know the exact depths at which the implement has been fishing. For the purpose of obtaining information in this respect various types of depth gauges have been used in the course of time, all of which have been measuring the depth by means of the water pressure. The simplest form of these depth gauges is the Kelvin tube, a glass tube sealed at one end and coated internally with a dye stuff soluble in water. When the water penetrates into the tube and compresses the air in the sealed end, the dye stuff will be dissolved in the part of the tube filled with water and when the tube has been hoisted in, the pressure of the water and thus also the depth may be determined by measuring the coated part of the tube. The main disadvantage of the Kelvin tube is, that it shows only the maximum depth of the gear and as the depth may vary greatly in the course of a haul, the Kelvin tube may give absolutely misleading results. In order to obtain an actual view of the movements of the fishing gear it will be necessary to use a depth gauge which graphically records the depths at which the net has been moving during the haul. In the course of time different recording depth gauges have been used, among which may be mentioned SCHÄFFER and BUDENBERG's depth gauge[1]), the British Admiralty depth gauge used by F. S. RUSSEL[2]), and a depth gauge used by WILLIAM BEEBE[3]).

In SCHÄFFER and BUDENBERG's depth gauge, and probably also in the two other instruments, of which no detailed descriptions are available, the water pressure will from the inside actuate a Bourdon tube which through a transmission will move a pointer. The pointer records the depth on a piece of recording paper moved by a clockwork, so that the depth will be recorded against the time.

The principal drawback of this apparatus is that it must be closed airtight whenever the apparatus is to be lowered into the water. In practice it is very difficult to ensure perfect tightness of the apparatus whenever it is to be used, and a slight leak will in many cases cause the clockwork to be destroyed by sea water. It is probably due to this drawback that these devices have been used only to a very limited extent despite the fact that they are badly needed in oceanographic research work.

[1]) Forschungsrejse S. M. S. "Planet", 1906-1907, B. III. Oceanographie, Berlin 1909, p. 11.

[2]) F. S. RUSSEL: Depth-recording with plankton-nets. Nature Vol. 115, 1925, pp. 603—604.
F. S. RUSSEL: Journal Marine Biol. Ass. Vol. XIII, p. 769, Plymouth, 1925.
F. S. RUSSEL: Ibid., Vol. XIV, p. 101. Plymouth, 1926.

[3]) WILLIAM BEEBE: Bermuda Oceanographic Expeditions, Zoologica, Vol. XIII, Nos. 1—2, New York, 1931.

In order to overcome this difficulty and to provide a reasonably handy and cheap apparatus, the author of this article in collaboration with conservator J. NIELSEN, Laboratoire Oceanographique, in 1946 constructed a new type of depth gauge for the "Kommissionen for Danmarks Fiskeri- og Havundersøgelser".

In this depth gauge the Bourdon tube recording the pressure is filled with air and tightly soldered, whereas the water may freely penetrate into the rest of the apparatus when it is in use. The recording is performed on a soot-coated glass plate which through a transmission gear is rotated by a propeller when the apparatus is pulled through the water. The apparatus thus records the depth against the distance travelled.

Description of the instrument.

The depth gauge (Figs. 1 and 2) is 49 centimetres long and weighs about 10 kilogrammes. It is suspended as shown in Fig. 1 on the wire in front of the fishing implement by means of two special suspension hooks, and a ball clamped to the wire between the hooks prevents the depth gauge from slipping along the wire.

The Propeller.

The propeller is provided with six adjustable blades and rotates the soot-coated glass plate through a worm gear and pinions. The glass plate makes one revolution for each 1,500 revolutions of the propeller. In the experimental tank at the "Hydraulisk Laboratorium, Danmarks Tekniske Højskole", the propeller was so adjusted as to make the glass plate make one revolution when the apparatus was drawn through a distance of about 2 nautical miles through the water. Within rather wide limits of speed the angle of turn of the plate depends solely upon the distance and not upon the speed.

The Bourdon Tubes.

As the depth gauge is to be used both for hauls in the uppermost 100 metres and for deeper hauls, it was necessary to provide it with three sets of Bourdon tubes in order to attain adequate sensitivity and a great measuring range. Each tube with its recording pointer is mounted on a plate which is screwed to the depth gauge, and the tubes may quickly be exchanged. The spirals move about 4 millimetres at the maximum pressure for which they are intended and the movement of the pointer is about 10 times as great.

The pointer on the first tube which may be used at depths from 0—125 metres will move about 3.5 millimetres for each 10 metres in depth. The accuracy of the depth measurements with this tube is about $\pm$ 2 metres.

The second tube may be used at depths of 0—700 metres and the deflection is about 5 millimetres per 100 metres in depth. Accuracy $\pm$ 15 metres

The third tube is intended for depths from 0—5,000 metres. This tube has not yet been tested.

The tubes are adjusted by lowering the apparatus to known depths and reading the corresponding deflections.

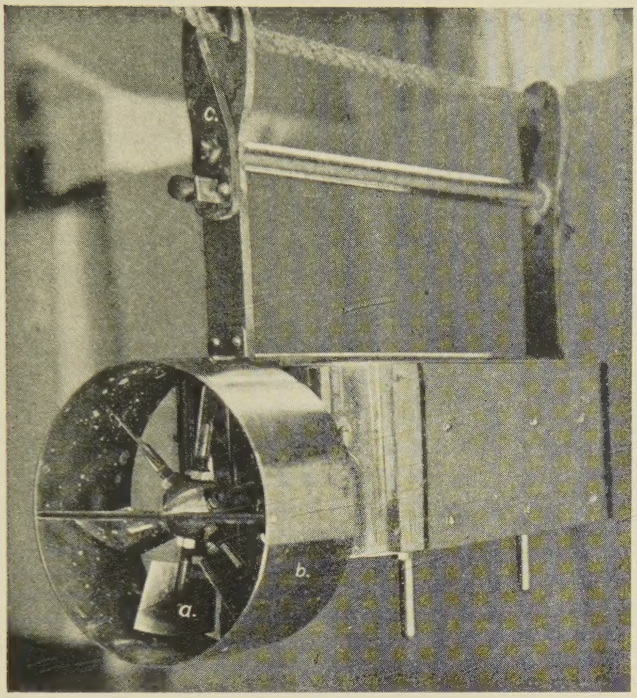


Fig. 1. The depht gauge suspended as on the trawl wire.
a. Propeller. *b*. Protective ring. *c*. Suspension hook.

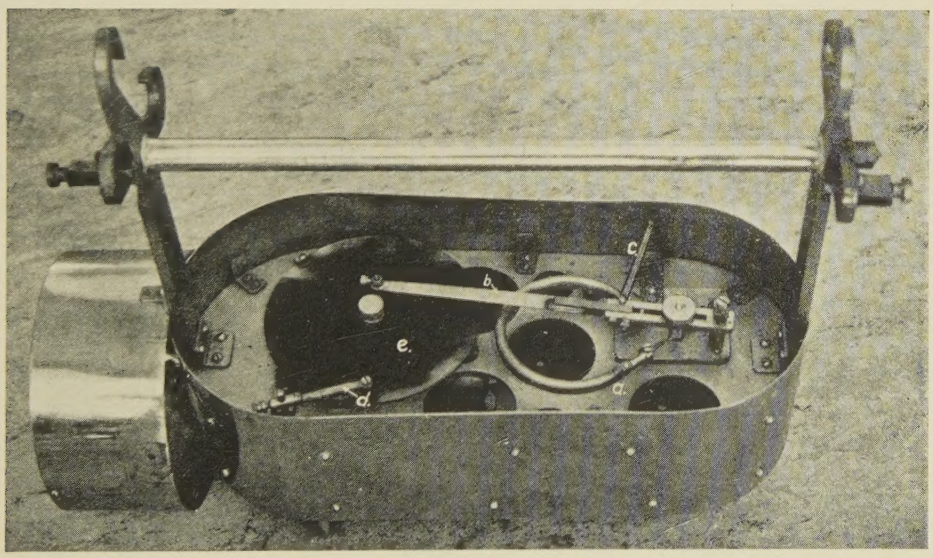


Fig. 2. The depht gauge with lid removed.
a. Bourdon Tube. *b*. Recording pointer. *c*. Spring. *d*. Centration pin. *e*. Soot-coated glass plate.

The Recording Plates.

For the recording circular, soot-coated glass plates of a diameter of 130 millimetres are used. Some of the plates were sooted on HÅKON MOSBY's method[1]), and other plates were while still warm after sooting poured over with a solution of paraffin in xylol, so that the soot was covered by a thin coating of paraffin. Before the plates were used they were tested by being placed in water for a couple of hours. If the soot did not loosen in this bath it would in almost all cases be capable of resisting the influences of sea water. After this test a rather considerable number of plates had to be condemned and re-sooted. The pointer moved by the Bourdon tube draws a line in the soot-coating with a fine bronze point. It proved possible to make the plate make three complete revolutions, corresponding to a distance of 6 nautical miles, without difficulties as regards readings.

To facilitate centering at the readings the apparatus is provided with a fixed bronze pin which draws a circle along the edge of the plate during its rotation. When readings were to be taken from the plate it was placed on a transparent scale illuminated from below. The soot-coating of the plate was so thin that the scale might easily be read through it.

Recording on a soot-coated glass plate entails the advantage that friction is reduced to a minimum, but as the actual sooting and the reading are rather cumbersome, experiments are now being made to replace the glass plates by celluloid plates with a thin layer of wax and printed scales.

The production of the depth gauge with three Bourdon tubes will presumably cost about Danish Kr. 1,500.00.

Results of the Depth Recordings.

The depth gauge was used on board the research vessel "Dana" in horizontal hauls with stramine nets in the summer of 1947, partly in hauls in the upper layers with up to 200 metres of wire and partly at greater depths with up to 1,000 metres of wire.

In 1948 the depth gauge was further used in hauls with pelagic trawl with a length of wire of up to 1,200 metres.

The experiments with the depth gauge showed that the depths at which the net had been fishing may vary to a very considerable extent even if the same length of wire was used. For instance, with 100 metres of wire the following depths have been recorded: 19, 20, 21, 21, 23, 32, 35, 39, and 45 metres. The depth at which the net is fishing depends not only upon the speed of the ship during the sweep but also, and to the same extent, of the speed of the ship while the net is being streamed and the speed at which the wire is being veered. If the ship is moving too slowly while the wire is being veered, the net will go too deep and only slowly approach its level during the haul.

Figs. 3—6 show examples of such depth curves measured from the soot-coated glass plates.

At station 6648, Fig. 3, the wire was first veered to 150 metres and a haul was made for 10 minutes with this length of wire, then 50 metres of wire were hauled in and a 10 minute haul made with 100 metres of wire. Finally 50 metres were hauled in and a 10 minute haul was made with 50 metres of wire. The irregularity of the curve for 150 metres of wire is due

*) HÅKON MOSBY: The Thermo Sound. Bergen's Museum's Årbok, Naturvitenskapelig rekke No. 1.

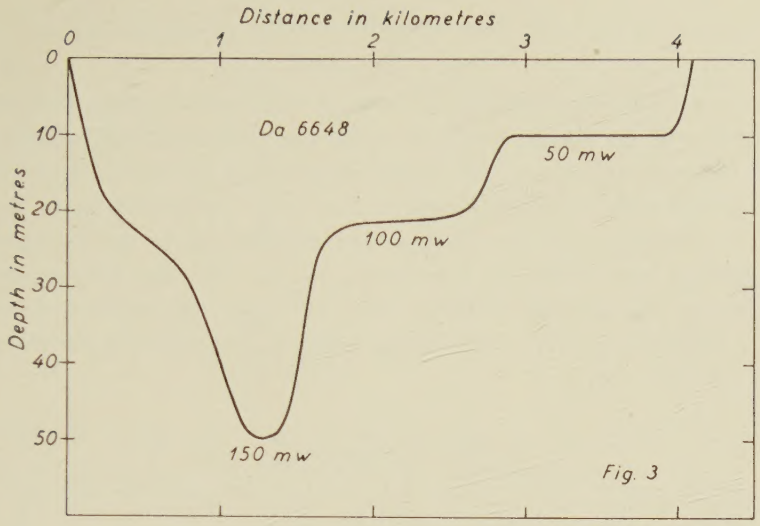


Fig. 3

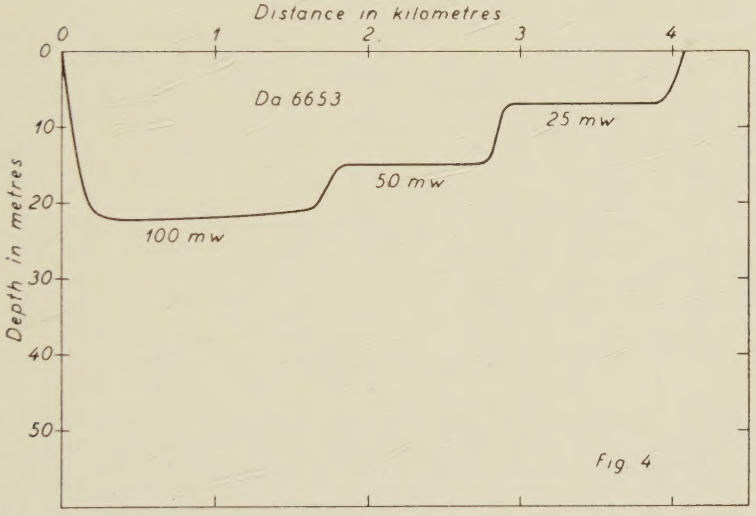


Fig. 4

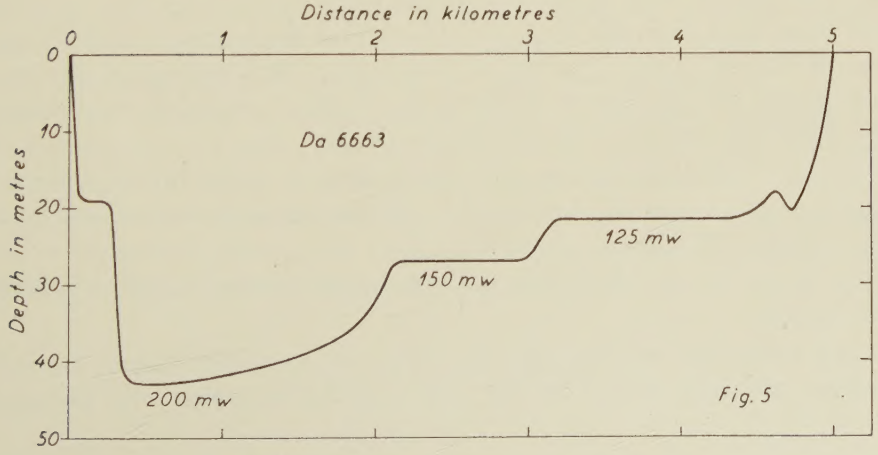
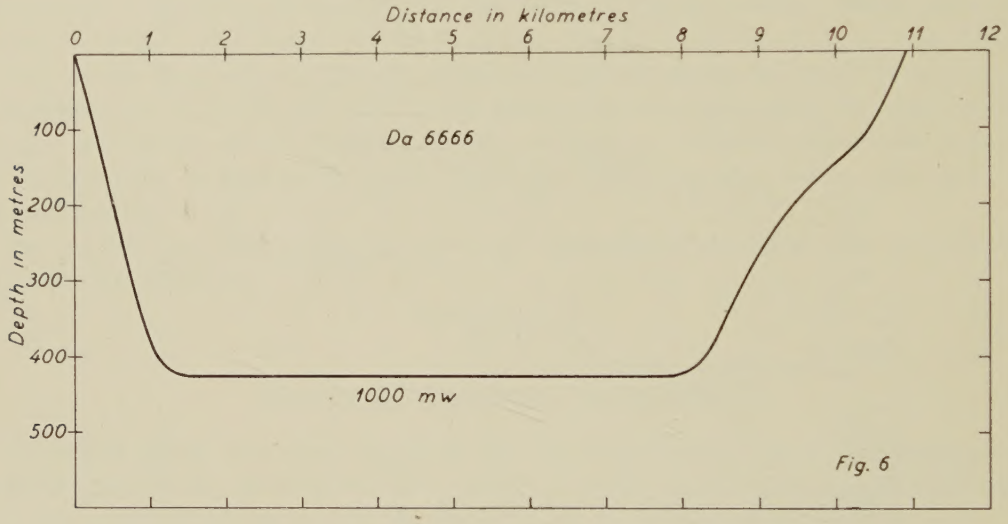


Fig. 5

to the fact that the speed of the ship was irregular during the haul, too fast at the beginning and later on too slow.

Fig. 4 (Station 6653) shows the curve for a haul with wire lengths: 100, 50 and 25 metres.

At station 6663 (Fig. 5) fishing was done with two stramine nets on the same wire with 100 metres of wire between the nets. The depth gauge was placed in front of the crow foot of the lowermost net. The first horizontal part of the curve appeared when the lowermost net had been veered to 100 metres and the veering was stopped while the second net was affixed to the wire. Then further 100 metres of wire were veered and the lowermost net was thereupon towed in the following lengths of wire: 200, 150 and 125 metres. During the hauling in the curve shows a slight irregularity indicating a stop in the hauling in while the uppermost net was removed from the wire.



At station 6666 (Fig. 6) four nets were operated on the same wire at the following depths: 200, 300, 600 and 1,000 metres of wire. The depth gauge was placed in front of the crow foot of the lowermost net. In this case the net was moving rather constantly at depths from 410—425 metres.

In most of the hauls with stramine nets the angle of the wire was measured and the depth ($l \cdot \sin v$) calculated from the angle of wire, v, and the length of wire, l, was compared with the depth measured. Table 1 gives a summary of the average depth measured, the number of sweeps and the differences between the depths calculated according to the angle and the depths measured for the different angles of wire.

It will appear from these figures that for lengths of wire 200, 150 and 100 metres, $l \cdot \sin v$ is on an average in excess of the depth. The wire must in these cases describe an arc with concavity upward.

At lengths of wire 50 and 25 metres the differences between $l \cdot \sin v$ and the measured depths are only small.

In the hauls with 1,000 and 600 metres of wire, the measured depths exceeded $l \cdot \sin v$. In these hauls four nets were placed on the wire at different depths with the depth gauge at

Table 1.

Length of wire, metres	Average depth, metres	No. of hauls	($l \cdot$ sine v — d) metres
200	44	3	10, 1
150	39	7	14, 14, 13, 12, 0, —1
125	28	3	—5
100	27	8	7, 5, 4, 3, 3, 2, —2, —5
50	13	7	—1, —2, —2, —2, —3, —5
25	7	2	—2, —2
1,000	420	1	—60
600	225	1	—20

the lowermost net. In these cases the horizontal pull on the wire by the uppermost nets has caused the wire to form an arc with concavity downward.

Table 2 gives a summary of the results of depth measurements at hauls with pelagic trawl at great depths. In these cases the direct measurements of the depths and the depths calculated according to the angle of wire, $l \cdot$ sine v, are almost identical.

Table 2. Depth Gauge on Pelagic Trawl. Tube 2.

Length of wire, metres.	$v°$	Measured depth, metres	$l \cdot$ sine v metres
1,200	30°	600	600
1,000	28°	460	470
700	30°	330	350
500	28°	240	235

Dansk resumé.

I 1946 fremstilledes en dybdemaaler til brug ved horizontale træk med straminnet og andre pelagiske fiskeredskaber. I dybdemaaleren (fig. 1 og 2) paavirker vandets tryk udefra en bourdonspiral, der bevæger en viser, som igen tegner paa en sodet cirkulær glasplade. Denne glasplade drejes rundt af en propel, naar apparatet, ophængt paa trawlwiren som paa fig. 1, trækkes gennem vandet. Man faar saaledes paa glaspladen en kurve, der viser dybden som funktion af den gennemfiskede strækning. Til apparatet hører tre bourdonspiraler beregnet til forskellige dybder. Spiral 1: 0—125 m, spiral 2: 0—270 m og spiral 3: 0—ca. 5000 m. Fig. 3—6 viser eksempler paa dybdekurver fra træk med straminnet.

Tabel 1 viser den gennemsnitlige maalte dybde for træk med straminnet med forskellige wirelængder, og desuden, i sidste kolonne, afvigelserne mellem dybder beregnet efter wirevinkel og wirelængde ($l \cdot \sin v$) og den maalte dybde.

Tabel 2 viser de maalte dybder ved træk med pelagisk trawl ved forskellige wirelængder. Der er her næsten fuldstændig overensstemmelse mellem den maalte dybde og dybden beregnet efter wirevinklen (sidste kolonne).

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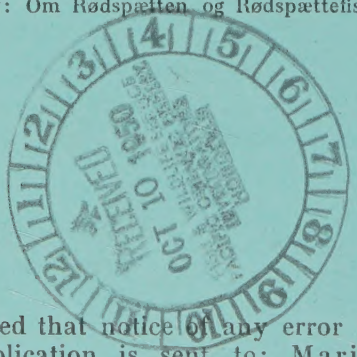

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